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A Novel Method of Sewage Disposal

ESPECIALLY DESIGNED FOR

THE CITY OF TORONTO

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Upon the assumption of a present population of 200,000 inhabitants,, the city of Toronto pours daily into the bay, and deposits upon the water front directly under the noses of her citizens, and beneath the keels of steamers and other craft frequenting the wharves, twenty tons of solid faecal matter, aggregating, during a year, the enormous quantity of 7,300 tons. To this must be added the solid excrementitious matter derived from stables, byres, slaughter-houses, and other extraneous sources, together with 16,000,000 gallons of excremental and other foul liquids. With the view of ameliorating the present conditions, C. H. Rust, city engineer, in his report of October 12th last, has recommended either of two methods of sewage treatment, i.e., intermittent filtration, the cost of which is estimated to be $730,000; or chemical precipitation, followed by filtration, presumably, through natural soil, at a cost of $550,000. The first mentioned process is estimated to involve an annual charge for maintenance of $70,000; the latter $105,000. Owing to the fact that, under the auspices of the Provincial Government of Ontario, the writer has been the pioneer of sewage treatment in Canada, that he has examined many of the best known plants in the United States, that he is in constant communication with United States State Boards, and is consequently in a position to be informed of the latest methods pursued there, it seems pardonable, in the interests of the community, to throw some additional light upon the very important question of the sewage disposal of this city.

Some time ago I outlined briefly in the columns of The Toronto Globe a method for the partial purification and disposal of the Toronto sewage. I now purpose entering more minutely into details which, since my letter was written, have been developed and elaborated, while the cost of construction and annual maintenance has been more correctly ascertained. The system of intercepting sewers recommended by Hering & Gray, with, perhaps, the slight modifications referred to in Mr.

Rust's report, will, of course, be a preliminary necessity, and somewhere upon the line of the outfall sewer in the vicinity of the Eastern city limits, the purification works, which I now advise as most suitable, regarding economy in construction, simplicity, and low cost of annual maintenance, as compared with other methods, should be located. The flow of sewage upon leaving the outfall sewer would first pass through a screening chamber, 10 by 20 feet, which would intercept foreign substances, thence the sewage would enter one or more of a series of eight receiving reservoirs, placed in a row, each reservoir being 34 by 40 feet, with graded floors some 18 or 20 feet lower than the sewer invert. These reservoirs would be fitted with metallic screens extending across the whole horizontal cross-section of each reservoir, to support coke strainers, the upper screen of all being intended to intercept all the solid faecal matter, and to prevent the latter from coming into contact with the coke strainers below. In this manner it is estimated that, with the present flow of sewage (16,000,000 gallons), about twenty tons of solid matter will be held back every 24 hours.

After passing through the coke strainers the fluid sewage, now purified to a very large extent, would be allowed to fall into the pump well, the bottom of which is designed to be 8 feet lower than the floors of the receiving reservoirs. This pump well would be about 285 feet in length, and 10 feet in width, with a capacity up to reservoir floor levels of about 140,000 gallons. Immediately adjoining the receiving reservoirs, and partially over the arched roof of the pump well, would be situated the pump and boiler house. The pumping plant would consist of a duplicate set of 24 inch centrifugal pumps. Each pump is calculated to discharge 25,000,000 gallons per 20 hours, against a total head of 40 feet (which includes the suction lift). The pumps would be run by a pair of 400 h.p. compound engines.

There would be a battery of 10 horizontal tubular boilers; each boiler of 100 h.p. Eight of these boilers are intended to supply steam for the pumps, the other two for drying out the receiving reservoirs and the contents thereof, coke and sewage matter, preparatory to the latter being run into the boiler house as fuel to be used under the boilers. The sewage effluent, after passing through the receiving reservoirs, and having been rid of all suspended and solid matter, would be as well purified as any chemical process of precipitation can accomplish, and could be allowed to pass by gravitation from the pump into Lake Ontario without further treatment, at any depth desirable below the surface, where diffusion would at once take place. But, if still further purification were at any future period insisted upon, either by local boards of health, or Governmental authority, two alternatives are open for such a purpose, viz., either by intermittent land filtration for which very much less than half the area suggested by the city engineer at page 12 of his report, would suffice; or, by the construction of two sets of artificial filters of the following materials and dimensions: Half an acre of coke filters, 3 feet 6 inches in depth; six acres of sand filters, 2 feet 3 inches in depth, the cost of which would not, in all probability, exceed $28,000. The last mentioned artificial filtration areas are larger, proportionately, than the supplemental filters in use at Glasgow, Scotland, for a similar purpose. The first alternative would necessitate the purchase of about 200 acres of land, besides its preparation, also an extra pump, while the cost of the last would be limited to material and construction only, as the sewage effluent would gravitate from the pump discharge to the filter beds.

In immediate proximity to the boilers and receiving reservoirs, there would be a brick chimney 250 or 300 feet in height. The object of such a high chimney is, by a powerful draft and steam heat, to carry off the objectionable fumes arising during the process of drying out the contents of the reservoirs, for which purpose a system of steam coils connected with one or two of the spare boilers is designed. Also, besides ventilating the reservoirs, it performs another very important function during the flow of sewage by creating a tremendous draft from the fresh air inlets upwards, and thus oxygenating the sewage most thoroughly, as the latter falls from one strainer to the other. Each receiving reservoir is capable of passing, and partially purifying from 2,000,000 to 4,000,000 gallons of sewage daily, after which it would be shut off from the sewer, thoroughly drained, and then subjected to a drying temperature of 300° F., which, assisted by the draft of the tall chimney would desiccate in a few hours the coke strainers and several tons of faecal matter intercepted by the upper screen, sufficiently to be used as ordinary fuel under the boilers, to which means have been designed to run them with a minimum of labor.

Such is the brief description of a very simple and economical plant, by which Toronto's sewage problem can be solved; and I wish here to point out particularly that this scheme involves an innovation hitherto unknown, or at least unpractised, so far as I am aware, in any sewage plant anywhere, i.e., the total and profitable combustion of the solids. By this process there is no resulting sludge to press and get rid of at considerable expense, the fuel bill is lessened, while the solid matters disappear in vapour.

It may be interesting to state here that, in any extensive chemical precipitation process the disposal of the sewage sludge has always been found an enormous drawback, as each million gallons of sewage treated produces from six to eight tons of pressed sludge cake, which it has been found impossible to get rid of without extra expense. Were such a system brought into use here, it is no exaggeration to say that the city would find itself compelled to hire daily, either a train of cars, or a small fleet of barges to haul it away. Farmers might take a very small percentage of it, but the great bulk would have to be carried away at the expense of the city, and 16,000,000 gallons of sewage daily treated chemically, mean 128 tons daily of pressed sludge cake. With regard to the coke strainers experience has shown, beyond a doubt, that after drying out, that material is as useful for fuel as before; and I shall show presently how it decreases the fuel bill, after having served its purpose as a strainer in the receiving reservoirs. It should be mentioned that this plant is amply capable of handling 16,000,000 gallons of the dilute sewage of Toronto per day, and that the receiving reservoirs can be added to if necessary; also that each of the pumps will discharge 25,000,000 gallons per day of 20 hours, with ease. The daily consumption of coke for straining purposes would be about 25 tons, or 175 tons per week, and the daily cost of pumping 25,000,000 gallons against a head of 40 feet would be 12 short tons of anthracite coal. Reduced to dollars and cents the daily cost for coke, coal and wages, may be represented as follows:

Pumping, 12 tons coal, steam drying, 3 tons coal; 15 tons coal, say at $3.75		$56 25
Deduct 25 tons coke recovered from reservoirs, valued at one-fourth its weight of coal=6.25 tons at $3.75	$23 43	
20 tons desiccated faecal matter, equivalent to 4 tons combustible matter, but not taken into account		23 43
		$32.82

The daily cost for labor would be:

Wages of two engineers at $2.50	$5 00	
Wages of four firemen at $1.75	7 00	
Wages of twelve laborers at $1.75	21 00	33 00
		$65 82
Add 25 tons coke required daily for strainers (high figure) at $4		$100 00
Total daily cost of maintenance		$165 82

Or $60,524.30 per annum

ESTIMATED TOTAL COST OF DISPOSAL WORKS.

Excavation	$30,000
Brickwork	30,000
Concrete	4,200
Iron work	6,000
Drying apparatus, coils, piping, etc	10,000
Ducts, or flues from receiving reservoirs to chimney	3,000
Flues from boilers to chimney	3,000
Roofing and carpenter's work	4,000
Bricking in boilers (10)	3,000
One centrifugal (24-inch) pump, one pair of 400 h.p. compound engines, 4 horizontal tubular boilers, aggregating 400 h.p.; feed pump, piping to connect boilers and engines, engines and pump set up on foundation, boilers placed ready to be bricked in $15 000	
In duplicate	30,000
Two additional boilers (steam drying)	2,000
Additional: suction and discharge piping, etc	1,000
Brick chimney (300 feet in height)	45,000
Coal and coke sheds	10,000
Eight branches connecting sewer with the different screening chambers, fitted with gates, and sundry other items	10,000
	$191,200

Note.—I am indebted to the Northey Mnfg. Co., Ltd., for the estimates as to the pumping apparatus and boilers.

It is important to explain here that the use of coke strainers has not been advocated without good reason. At Lawrence, Mass., U.S.A., experiments by the State Board upon the best known methods of sewage disposal have been tried during the last decade, and the results of the last two or three years, with regard to coke strainers, have shown that a 6-inch layer of that material has purified city sewage at the rate of 1,000,000 gallons per acre daily, and removed 62 per cent. of the organic matters (albuminoid ammonia), and 50 per cent. of that determined as "oxygen consumed," also that, at the rate of 4,000,000 gallons per acre daily, 38 per cent. of the total organic matter has been eliminated. The report of 1896 states emphatically besides, that coke straining removes organic matter as thoroughly from sewage as it is possible to do with any chemical or sedimentation process whatsoever, besides having the advantage of getting rid of the concentrated sludge liquor. It must also be remembered that, in the method which I have now advised, I have gone a step forward, by the retention of the solid faecal matter above, and entirely out of contact with, the coke strainers, thus relieving the latter of a very large percentage of organic matter to be dealt with. Obviously this is equivalent to increasing proportionately the area of the straining surface. The total combustion of the solids under the boilers, and the riddance of the expensive and intolerable sludge nuisance, are also advantages which must weigh with, and appeal to, even the least thoughtful of municipal economists.

It has been said that intolerable smells would arise from this combustion process. Not so. The high chimney will cause any bad odors to be carried away and dissipated in the atmosphere, far above the highest part of the city or neighborhood.

I may instance the Townsend and St. Rollox chemical works chimneys at Glasgow, Scotland, besides others in England, Germany, and in the United States, situated in the midst of dense populations, which carry off immense volumes of most deleterious gases, without inconveniencing the people below; but a little consideration will satisfy the most sceptical that nothing need be feared upon that score.

Mr. Rust estimates the cost of 600 acres of land, and the preparation of 300 acres for intermittent filtration, at $240,000. This, of course, presupposes the land to effect the purification of the crude sewage as it comes from the sewers.

My estimate for a filtering area of suitable natural soil, such as is said to be available to the northeast of the city, would be a tract of only 200 acres, which is amply sufficient to effect the final purification of the partially purified effluent from the coke strainers, being at the rate of 160,000 gallons per acre daily, for 16,000,000 gallons of a daily output. Such an area, upon the basis of Mr. Rust's estimate, would certainly cost less than $80.000. In the event, therefore, of a pressing public demand for complete purification, by final filtration through natural soil, entire and thorough treatment would cost, by the method I have outlined, as follows:

Coke straining and combustion works, pumping station etc	$191,200
Land for above (Mr. Rust's estimate)	10.000
Extra pumps, boilers, etc., required for pumping to land northeast of the city	30,000
Force main (Mr. Rust's estimate)	115,000
Two hundred acres of land for filtration purposes, and preparation, being taken at exactly the third of Mr. Rust's estimate. This is manifestly too high	80,000
	$426,200

Which is only 57-100ths of the city engineer's estimate for the cost of intermittent filtration and 75-100ths of that of his chemical precipitation scheme, *which has still the sludge to deal with.* The three proposed processes now stand thus, as regards cost of construction:

Coke straining and combustion process, followed by intermittent filtration	$426,200
City engineer's estimate for intermittent filtration	730,000
City engineer's estimate for chemical precipitation	555,000

And, as regards cost of maintenance per annum:

Coke straining and final purification by intermittent filtration	$65,000
City engineer's estimate for intermittent filtration	70,000
City engineer's estimate for chemical precipitation	105,000

In conclusion, I may remark that the coke straining may be carried to any extent by more frequent changes of coke than I have allowed for, it is simply a question of more coke and less coal, but the quantity estimated (175 tons weekly), will purify quite sufficiently for all practical purposes, especially if followed by intermittent filtration.

In the foregoing, the lift from the pump well to the filtration area, recommended by Mr. Rust, has been assumed to be only 70 feet vertically. This is not correct, the elevation being much greater, as I am now reliably informed. So much so, indeed, as to bring the annual cost of maintenance by my combined method, up to $100,000 or more. This, in view of the much more economical second alternative plan, is almost prohibitive. The artificial filters referred to may now be considered as offering the better method of subsidiary, and final purification. The long, narrow spit of land between Ashbridge's Bay and Lake Ontario presents an excellent location for the small area required, and can be reached by gravity within a moderate distance from the coke and combustion works, should local circumstances prevent their location in close proximity to the latter.

The half acre of coke and six acres of sand and gravel filters already mentioned, would be sufficient, as at Reading and Glasgow, but, inasmuch as coke would require frequent renewal, and the other materials are to be had in abundance in the locality designated, it would be more economical to lay out 8 or 10 acres of sand and gravel beds at a maximum cost of, say $40,000. The probability is that quite sufficient material is on the spot *in situ*, and that the filters, on a much more extensive scale, and at very much less cost, could be made out of the land.

The total cost of the whole plant, including coke and combustion works, on the line of the outfall sewer, the filtration area, and a possible mile of conduit pipe from the works to the filter beds, would be, approximately, as follows:

Coke and combustion works	$191,200
Land for above	10,000
Conduit pipe	40,000
Filter beds	40,000
Cost of land, right of way, etc.	25,000
	$306,200

The artificial beds at Reading, Penn., U.S.A., cover an area of 57-100 acre, only, they filter 1,500,000 gallons of sewage effluent daily, and the preliminary coke straining of the "entire" crude sewage is by no means as thorough as it should be, the strainers being changed but once a week, and yet the effluent from these very small filters is satisfactory. In this case (Toronto), the heavy matters of the sewage are entirely held back from the coke strainers, there is constant aeration, and, with a larger filtration area, proportionately, can we not look for even better results ?

No sludge, a minimized cost of construction, and a yearly cost for maintenance not exceeding $73,000, which covers the care of the filter beds.

The construction of half an acre of coke filter at the works (at the discharge end of the pumps), would add greatly to the purity of the effluent from the sand and gravel filters at Ashbridge's Bay, and be well worth the outlay. Such a filter would cost about $15,000, and bring the total outlay for construction up to $321,200. It would probably suffice to renew such a filter at the rate of, say ten tons daily, which, as the coke from the strainers in the receiving reservoirs, would be utilized as fuel, and pay for itself.